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(54) **SMART PHONE ATTACHMENT FOR 3-D OPTICAL COHERENCE TOMOGRAPHY IMAGING**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

6,396,587 B1	5/2002	Knupfer et al.	356/479
7,400,409 B2	7/2008	Hauger et al.	356/479
7,488,070 B2	2/2009	Hauger et al.	351/200
8,115,934 B2	2/2012	Boppart et al.	356/479
9,198,573 B2 *	12/2015	Raymond	A61B 3/102
2012/0101390 A1 *	4/2012	Iftimia	A61B 5/0035
			600/476
2014/0285812 A1 *	9/2014	Levitz	A61B 5/0066
			356/479

(Continued)

OTHER PUBLICATIONS

Ahmad et al., "Cross-correlation-based image acquisition technique for manually-scanned optical coherence tomography," *Opt. Express*, vol. 17, No. 10, pp. 8125-8136 (May 2009).

(Continued)

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(57) **ABSTRACT**

Methods and apparatus for tomographic imaging of a sample. Low-coherence light is split into a sample path and a reference path. A steering optic recombines light in the reference path with light scattered by a sample onto a camera having an areal focal plane array of detector elements such that light in the reference path and light scattered by the sample are characterized by respectively offset propagation vectors at incidence upon the camera. A processor derives depth information from light scattered by the sample on the basis of interference fringes between light in the reference path and light scattered by the sample. The apparatus tracks lateral motion and may be hand-held or attached to a mobile device such as a smartphone, thus enabling 3-D imaging with the mobile device.

26 Claims, 5 Drawing Sheets

